Report from the

ERASMUS+ BIP European Training School

"Artificial Intelligence in Healthcare, Clinical Pharmacy, and Optimization of Pharmacotherapy: New Advances in Research and Clinical Practice"

In the period **from April 28 to May 2, 2025** was organized the **BIP ERASMUS+ European Training School** of the Faculty of Pharmacy, Charles University in the Czech Republic titled **"Artificial Intelligence in Healthcare, Clinical Pharmacy, and Optimization of Pharmacotherapy: New Advances in Research and Clinical Practice"** that focused on unique aspects of AI (artificial intelligence) and ML (machine learning) analytical methods in geriatric clinical pharmacy and optimization of pharmacotherapy for modern development of healthcare practice and research. This European Training School introduced to participants current ways of the utilization of AI methods in clinical pharmacy and pharmacoepidemiologic research and emphasized new challenges in the optimization of pharmacotherapy in older patients during future decades in which the proportion of older adults in the society and healthcare will rapidly increase. This European training school helped participants to gain new theoretical knowledge and practical skills in the optimization of geriatric pharmacotherapy and AI/ML methods and increased collaborative effort on future outputs in this area.

The ERASMUS+ BIP program consisted of 2 virtual activities with participants (held before the physical activity on April 17, 2025 and after the physical activity on June 26, 2025) and from 5-day physical training school organized in Prague, Czech Republic. Each day of the physical training consisted of morning professional lectures of the renowned European experts in geriatric clinical pharmacy, optimization of geriatric pharmacotherapy, deprescribing, AI modelling and geriatric pharmacoepidemiology. In the afternoon were held practical workshops and collaborative working sessions. In the scientific program of this BIP ERASMUS+ training school were involved 6 speakers/clinicians/researchers from the I-CARE4OLD EU Horizon 2020 project research group (the project that for the first time in Europe tested outcomes of pharmacological and non-pharmacological interventions in older patients by using machine learning (ML) methods and complex data of millions of seniors), 3 speakers/experts from the European Society of Clinical Pharmacy (mainly from the Research Committee of the ESCP and the Special Interest Group on Deprescribing of the ESCP), experts from the University Centre of Clinical Pharmacy at the Faculty of Pharmacy, Charles University and participants from 10 Universities of 9 EU countries, namely the Ghent University in Belgium, Belgrade

University in Serbia, Trinity College in Dublin and University College Cork in Ireland, University of Zagreb in Croatia, D'Annunzio University of Chieti–Pescara in Italy, Commenius University in Slovakia, Lithuanian University in Tallin, Yeditepe University in Turkey and Charles University in the Czech Republic.
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Experiences from professional and social programs of individual days are summarized by participants bellow:

ERASMUS+ BIP European Training School - Day 1- Monday- April 28, 2025 Charles University, Karolinum, Prague, Czech Republic

Day 1-Monday- morning sessions

The first day of the training school was held in Karolinum, Charles University, Prague, in the Small Hall (Malá aula). The program started with the welcome session and introduction by Assoc. Prof. Daniela Fialová from the University Centre of Clinical Pharmacy, Charles University. During this session, participants were introduced to the objectives of the training school, its interdisciplinary focus, and its relevance for advancing clinical pharmacy practice in Europe. Prof. Fialová emphasized the importance of continuous education in medication reviews, patient safety, and the integration of new technologies such as AI in clinical pharmacy practice. She also provided practical information about the schedule, logistics, and expected outcomes of the training school.

The next session was held by Prof. Annemie Somers from the Ghent University Hospital, Belgium with a lecture on clinical pharmacy medication reviews in complex older patients. She outlined the current challenges in managing polypharmacy among older adults, focusing on the risks of adverse drug events, drug interactions, and inappropriate prescribing. Prof. Somers discussed current needs in clinical pharmacy, such as improved medication reconciliation processes, comprehensive reviews, and better communication among healthcare providers, all through a case study discussion. She then explored future possibilities and the limitations of using AI tools in clinical practice, discussing how AI can support medication reviews by identifying potentially inappropriate medications and optimizing therapeutic choices. However, she emphasized the limitations of AI, such as data quality dependency, lack of contextual understanding, and the irreplaceable role of clinical pharmacists' judgment and patient-centred approach. The session in the program was an interactive workshop held again by Prof. Annemie Somers on practicing complex medication reviews in geriatric patients with polypharmacy. During this session, participants worked on real-life case scenarios to analyse patients' medication regimens, assessing risks and benefits, and identifying opportunities for deprescribing. This interactive part encouraged group discussion on

how to approach deprescribing while considering patient preferences, clinical guidelines, and risk mitigation strategies to improve treatment outcomes in older patients.

Day 1- Monday- afternoon sessions

The afternoon session of Day 1 began with Prof. Hein van Hout´s lecture from the Amsterdam Medical Centre, Netherlands. He presented the I-CARE4OLD Horizon 2020 project, which focused on developing and implementing AI and ML methods to improve care for older adults with complex health needs. Prof. van Hout detailed the aims, outputs, and impacts of the project, including the integration of AI models to predict health deterioration, to support clinical decision-making, and enhance personalized care in geriatric populations. Participants learned about the design, data collection strategies, methodological challenges, and the potential for scaling up the use of AI tools across different healthcare systems in Europe.

The following session was led also by Prof. van Hout and focused on how to write a European grant. He outlined the critical steps in grant writing, including defining clear objectives, formulating research questions, developing work packages, and aligning the proposal with European Commission priorities such as innovation, patient-centred care, and digital health transformation. He shared tips for ensuring clarity, coherence, and competitiveness of grant applications, as well as common pitfalls researchers should avoid. After a short coffee break, the final session of the day took place, again with Prof. van Hout, focusing on how to appropriately use AI tools in grant and research proposal writing. This practical session guided participants through identifying AI applications relevant to their research fields, integrating AI-based methodologies into proposals, and ensuring ethical and realistic use of AI within project plans. The session also included practical exercises to apply learned principles to their upcoming grant ideas. In this session, participants had a chance to write their own abstract/short proposal for the European grant, where they could use all the tips and trick that they learnt in the session prior to this task.

The Day 1 ended at the typical Czech restaurant „U Graffů" in Prague with delecious dinner where participant continued in dicsussions and networking activities.

DAY 2- ERASMUS+ BIP European Training School - Tuesday- April 29, 2025

Charles University, Karolinum, Prague, Czech Republic

Day 2- Tuesday - morning sessions

The day began with the lecture of Prof. Mark Hoogendoorn, the ML expert from the Vrije University, Amsterdam, Netherlands, delivering a keynote on innovative directions in health statistics using AI/ML techniques. He outlined how modern machine learning can analyze increasingly complex health data, opening new opportunities for personalized medicine, predictive modelling, and efficient resource allocation in healthcare. Prof. Hoogendoorn emphasized the importance of interpretability and transparency in deploying AI/ML solutions in health contexts, highlighting case studies where AI has successfully predicted health outcomes or optimized treatment pathways.

Prof. Rosa Liperoti from Università Cattolica del Sacro Cuore, Rome, Italy, presented significant results from the I-CARE4OLD H2020 project, focusing on the negative clinical impact in new users of antipsychotic medications and strategies for discontinuing antipsychotics in older adults with complex health needs. Her talk delved into the challenges of balancing therapeutic efficacy with minimizing adverse outcomes in geriatric patients, who often have multiple comorbidities and are more susceptible to medication side effects. She shared insights into how data-driven approaches and rigorous statistical analyses have informed safer prescribing practices.

After a short break with networking over coffee and discussing the morning's insights, Dr. Mikko Nuutinen from Nordic Healthcare Group, Helsinki, Finland, explored how AI/ML tools can be leveraged to analyze medication outcomes in older adults with complex health profiles. He illustrated the use of predictive models to identify patients at high risk of adverse drug events and discussed how ML can complement traditional clinical trials by providing real-world evidence.

Later on, Assoc. Prof. Daniela Fialová presented further findings analyzed from the I-CARE4OLD data, this time focusing on anticholinergic medications. She discussed how certain anticholinergics, though sometimes beneficial, can contribute to significant cognitive and physical decline in older adults. Her presentation examined both the benefits and harms of these medications, strategies for safe deprescribing and how AI/ML analyses have improved understanding of medication-related risks in geriatric care. She stressed the importance of integrating clinical expertise with data science insights to personalize treatment decisions, as well as the importance of newly funded multicentric project NETPHARM, which in WP4 aims at developing the first research cooperation of clinical pharmacy centres in the Czech Republic. Then followed a lunch break during which participants had again possibilities to discuss knowledge gained during the morning sessions.

Day 2- Tuesday- afternoon sessions

In the afternoon on Day 2, Dr. Louk van Remmerden from Vrije University, Amsterdam, Netherlands, opened the session by explaining methods how to examine the impact of non-pharmacological interventions in older adults. He described the methodological and practical challenges faced when evaluating these interventions, such as difficulties in standardizing interventions, patient adherence, and capturing meaningful outcomes. His insights were particularly relevant for researchers aiming to generate robust evidence in areas where randomized trials are harder to conduct. The final major session was a practical workshop focusing on applying AI/ML to epidemiological outcome analyses of big data. Participants formed groups, so that in each group there was at least one person with Phyton experience. Then a few trainers guided them through coding exercises, demonstrations of ML pipelines, data cleaning, and practical tips for implementing advanced analyses. Topics included handling missing data, feature selection, model validation, and interpreting outputs to inform clinical decision-making. This track provided participants with conceptual understanding without requiring programming. It focused on principles of ML methods, practical considerations for collaborating with data scientists, and understanding how results can guide clinical practice. The practical session was concluded by prof. van Hout who awarded small prices to the best 3 teams for Monday works on their tasks in the session on international grant proposals writing .

Attendees were then encouraged to continue networking informally and explore Prague culture and beauties in their free evening.

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DAY 3- ERASMUS+ BIP EU Training School - Wednesday- April 30, 2025

„Day with the ESCP" at the Faculty of Pharmacy, Charles University, Czech Republic

During this day participants of the ERASMUS+ BIP European Training School traveled to visit Faculty of Pharmacy, Charles University in Hradec Králové, where in big aula of the new campus was organized a „Day with the ESCP- European Society of Clinical Pharmacy". President and other representatives of the ESCP visited the Faculty of Pharmacy, gave their lectures and held discussions with students and academicians on international development of clinical pharmacy particularly in research and clinical practice. Representatives of the Czech departments of clinical pharmacy from various regions of the Czech Republic were invited to this event. A special report on this day is summarized also on the website of the University Centre of Clinical Pharmacy, Faculty of Pharmacy in Hradec Králové, Charles University, Czech Republic (www.faf.cuni.cz/uckf).

DAY 4- ERASMUS+ BIP European Training School – Thursday- May 1, 2025

Institute for Mother and Child, Prague, Czech Republic

Day 4- Thursday - morning sessions

Thurday morning program was devoted to academic lectures of representatives of the European Society of Clinical Pharmacy. PharmDr. Monika Lutters, Ph.D., President of the European Society of Clinical Pharmacy (ESCP), shared her vast clinical experience in leveraging AI tools to predict adverse drug reactions and introduced several projects conducted in her academic hospital. Her insights, supported by referencing of various innovative studies from Europe and Canada, highlighted the tangible impact AI-driven clinical decision support systems are making in enhancing patient safety and optimizing

pharmacotherapy, particularly in complex older patients. Dr. Lutters motivated participants also to take part in activities of the European Society of Clinical Pharmacy, particularly in the group of "Young ESCP" colleagues and emphasized several current research efforts in clinical pharmacy using AI methods.

Prof. Martin Henman, Chair of the ESCP Research Committee, addressed the ethical landscape of AI in the healthcare. He emphasized the importance of maintaining patient autonomy, safeguarding data privacy, and ensuring algorithmic transparency and accountability. His reflections emphasized that ethical frameworks must evolve alongside technological advancements to maintain public trust and protect patients´ rights. He discussed with participants their experiences with ethical barriers for using AI in clinical practice and research and gave many practical examples of current gaps in utilization of AI tools and methods in clinical practice. He also invited participants to the ESCP Masterclass and ESCP Symposium in Grenoble, France, which will be specifically devoted to utilization of AI methods in clinical pharmacy.

Day 4- Thursday - afternoon

Cultural trip to Karlštejn Castle, Karlštejn, Czech Republic

In the afternoon, the program included a guided cultural tour to Karlštejn Castle, built by Emperor Charles IV. in the 14th century as a king´s summer castle. This enriching experience provided historical context and deepened appreciation of European training school participants to Czech cultural heritage.

DAY 5- ERASMUS+ BIP EU Training School – Friday- May 2, 2025

Institute for Mother and Child, Prague, Czech Republic

Day 5- Friday- morning sessions

During the final day of the European training school the teams of students from various Universities showcased their student presentations about their research and clinical interests, University research teams and about studies at their Universities.

Students had the opportunity to present an overview of home institution's academic structure and share insights into the educational philosophy of their faculties of pharmacies, how these institutions support education and research direction in clinical pharmacy and what are Universities key educational and research interests. Open discussions followed, focusing on fostering international academic collaboration, building research networks, and exploring opportunities for future joint projects in AI and clinical pharmacy. The program concluded with certificates award ceremony, closing remarks from the faculty organizers, and a shared affirmation of students´ collective commitment to innovative, ethical progress in the clinical pharmacy field.

The training school ended with the lunch of all participants and other attending professionals in the near Restaurant Kotva close to the Vltava River.

Evaluation of the ERASMUS+ BIP European Training School by participants:

„Participating in the ERASMUS+ BIP Training School titled **"**Artificial Intelligence in Healthcare, Clinical Pharmacy, and Optimization of Pharmacotherapy: New Advances in

Research and Clinical Practice", held in Prague, Czech Republic from April 28th to May 2nd, 2025, was truly one of the most outstanding professional and personal experiences we have ever had. From the outset, the Training School impressed us with its meticulously organized program and world-class speakers. It was evident that the organizers, led by Assoc. Prof. Daniela Fialová from the University Centre of Clinical Pharmacy, with great help from Miss Monika Trda, had poured immense effort and expertise into creating an event of exceptional quality. Throughout the sessions, we were immersed in cutting-edge discussions on the integration of AI and ML in healthcare, particularly in the context of clinical pharmacy and geriatric pharmacotherapy. The lectures covered an impressive range of topics, from technical AI methodologies to the clinical realities of pharmacotherapy in older adults. The morning and afternoon sessions were punctuated by well-timed coffee breaks and a lunch that provided ample opportunity for networking and exchanging ideas. We were consistently surrounded by colleagues from a wide variety of professional backgrounds - pharmacists, physicians, researchers, and data scientists - which led to fascinating discussions and potential future collaborations.

Except lectures given by excellent and well-selected European speakers we had an opportunity to train our skills in practical workshops (e.g. on conducting epidemiological analyses using AI/ML methods, on application of AI in clinical practice etc). Beyond the educational sessions, one of the most rewarding aspects was the opportunity to connect with so many talented and passionate colleagues from all over Europe and beyond. Representatives from ten universities - Ghent University Belgium, Belgrade University in Serbia, Trinity College Dublin or University College Cork Ireland, University of Zagreb Croatia, D'Annunzio University of Chieti–Pescara Italy, Yeditepe University, Istanbul, Turkey and others - all students brought diverse perspectives and experiences. Conversations ranged from deep scientific debates to sharing practical challenges faced in different healthcare systems. The environment was incredibly collegial and many of us are already planning future collaborations born out of these connections. Adding an extra layer of magic to the entire experience was the spectacular setting of Prague. Attending lectures in the historic halls of Karolinum, walking through the cobbled streets of Staré Město, and enjoying views of Prague Castle created an unforgettable backdrop for our learning. The city's rich history and vibrant culture made every moment outside the classroom equally rewarding. Whether it was sharing coffee in beautiful historic venues, attending the social afternoon at Karlštejn Castle, or simply strolling along the Vltava River in the evening, the location contributed immeasurably to the sense of camaraderie and inspiration.

In summary, the ERASMUS+ BIP Training School in Prague was an exceptional and transformative experience. We are leaving not only with new scientific knowledge and practical skills, but also with an expanded network of colleagues and friends who shared a common vision for advancing healthcare through innovation and interdisciplinary collaboration. It was a perfect blend of rigorous academic learning, skills development, professional networking, and cultural enrichment.

We are immensely grateful to the organizers, speakers, and all participants who contributed to making this Training School such a resounding success. We look forward with great enthusiasm to continuing the collaborations and friendships that began in the beautiful city of Prague."

Text: participants of the training school from 10 Universities

Photos: Monika Trdá

Acknowledgment

This European training school was organized by ERASMUS+ BIP program of the Charles University, Faculty of Pharmacy.

Co-organizers were

- Researchers from the European consoricum of the I-CARE4OLD H2020 project
- Members of the Research Committee of the ESCP - European Society of Clinical Pharmacy
- Members of the Special Interest Group on Deprescribing of the ESCP - European Society of Clinical Pharmacy
- University Center of Clinical Pharmacy, Faculty of Pharmacy, Charles University
- Researchers from the WP4 team of the NETPHARM project
- Collaborating 10 Univerities of 9 countries

The projects and organizations supporting this event played no role in formulation of the texts of this report.